

## COLOR AND DENSITY CALIBRATION OF COLOR PRINTERS

### BACKGROUND OF THE INVENTION

The present invention is generally related to image output devices and more  
5 specifically related to color calibration and density calibration of color printers.

Image output apparatuses such as printers, faxes, copy machines, or multifunction  
peripherals which may include some or all of the aforementioned devices and even other types  
of image producing devices are used to produce images based on an input. Color image  
output devices typically produce color images by mixing together primary colors. If the color  
10 to be output matches one of the primary colors, then only that color is used. However, most  
colors require a combination of the primary colors. The image output device's engine  
determines an amount of the primary colors to mix.

A problem with color devices is that there can be variations in the output produced by  
the primary colors. The colors can become unbalanced creating relative differences between  
15 the primary colors, thus mixing the color causes unacceptable tints in the output image. The  
relative differences in colors can be caused by a variety of factors, including but not limited to,  
aging of various components, temperature and humidity changes, and changes between  
batches of inks used to create the image.

Although image output engines attempt to monitor and keep the relative densities of  
20 the color outputs the same, these methods are typically not 100% effective. Thus, the need  
exists for a method wherein a user can visually calibrate the image output device.

Another common and similar problem with image output apparatuses such as printers  
is balancing the lightness-darkness sum of marking channels. This can cause images produced  
by the apparatus to be too dark or too light and details in the image can be obscured.

25 Although image output engines attempt to monitor and keep the relative light-dark  
densities the same, these methods are typically not 100% effective. Thus, the need exists for a  
method wherein a user can visually calibrate the relative light-dark density of an image output  
device.

## BRIEF SUMMARY OF THE INVENTION

In view of the aforementioned needs for color calibration, the present invention contemplates a method that uses a color sensitive image and provides a reference for a user to 5 compare with the color sensitive image.

One aspect of the invention is for a method for visually calibrating a color printer, comprising the steps of providing an interface for receiving commands, providing a color reference, the reference comprising a plurality of colors, outputting a predetermined image, visually comparing the predetermined image with the reference, receiving a bias color 10 selection, and adjusting the printer engine based on the received bias color. In addition to selecting a color, the reference may provide a plurality of intensities for each color. The interface may be a control panel interface on the image output device, or the interface can be implemented by a printer driver on a remote computer communicatively coupled to the color printer. When a printer driver is used on a remote computer, the color reference can be 15 displayed on a monitor coupled to the remote computer. Other aspects of the present invention include an image output apparatus and a computer readable medium of instructions with means for implementing the aforementioned method.

In view of the aforementioned needs for light-dark density calibration, the present invention contemplates a method that uses an image that is sensitive to light-dark errors. The 20 image contains important details in the highlight and shadow regions of usage, which when missing

One aspect of the present invention is a method for determining that an image output device is in an acceptable density range, the image output device having an image output engine, comprising the steps of outputting a predetermined image, visually comparing the 25 predetermined image with a reference, selecting an adjustment parameter; and adjusting the image output engine based on the adjustment parameter. Preferably the reference comprises a plurality of images, each image having a different background. Normally, an image is shown once with a dark background and again with a light background. By determining whether there are details missing, and from which background, a user can adjust the printer. When all

of the details of the image are visible, then the printer has an optimal light-dark balance. An interface is used for commanding the image output device to print the predetermined image and to input the adjustment parameter. The interface may be either a control panel on the image output device, or a printer driver running on a remote computer communicatively coupled to the image output device. Normally, the adjustment parameter is selected from the group consisting of lighten, darken and no adjustment. It is further contemplated that the reference or the adjustment parameters can be a group with various shades of lightness or darkness.

Other aspects of the present invention include an image output apparatus and a computer readable medium of instructions with means for implementing the aforementioned method.

Still other objects of the present invention will become readily apparent to those skilled in this art from the following description wherein there is shown and described a preferred embodiment of this invention, simply by way of illustration of one of the best modes best suited for to carry out the invention. As it will be realized, the invention is capable of other different embodiments and its several details are capable of modifications in various obvious aspects all without from the invention. Accordingly, the drawing and descriptions will be regarded as illustrative in nature and not as restrictive.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings incorporated in and forming a part of the specification, illustrates several aspects of the present invention, and together with the description serve to explain the principles of the invention. In the drawings:

5 FIG 1 is an illustration showing an example reference image for use with color calibration along with bias colors and intensities;

FIG 2 is a block diagram of steps contemplated by a preferred embodiment of the present invention;

10 FIG 3 is an illustration showing an example reference image for lightness-darkness density calibration; and

FIG 4 is a block diagram of steps contemplated by a method of the preferred embodiment of the present invention for lightness-darkness density calibration.

## DETAILED DESCRIPTION OF INVENTION

Throughout this description, the preferred embodiment and examples shown should be considered as exemplars, rather than limitations, of the present invention.

One aspect of the present invention is for a method of performing visual calibration for 5 balancing the colors of a color printer. The method comprises printing a composite that is very sensitive to relative intensities of the color channels used by the printer, which are normally cyan, magenta, yellow. A user compares the composite to a reference image and looks for any tints or hues on the composite that are abnormal to the reference image. The user then inputs a bias color to indicate the color that appears on the composite. The image 10 output apparatus then performs internal adjustments based on the input bias color.

Referring to FIG 1 there is shown an example reference image 102 and bias color bars A 104a, B 104b, C 104c, D 104d, E 104e, F 104f, H 104g and G 104h. As shown in FIG 1, color bar A 104a is yellow, color bar B 104b is orange, color bar C 104c is red, color bar D 104d is magenta, color bar E 104e is violet, color bar F 104f is blue, color bar G 104g is blue- 15 green and color bar H 104h is green. As shown in FIG 1, each of the aforementioned color bars has various intensities, numbered 1-5 where 5 represents the darkest intensity for the color and 1 the lightest.

Referring now to FIG 2 with continued reference to FIG 1, there is illustrated a method 200 of the preferred embodiment. The method begins at step 202 by printing a predetermined 20 image (not shown), which should match the reference image 102. Preferably, the image is sensitive to relative intensities of the color channels used by the printer, normally cyan, magenta and yellow. The predetermined image is then visually compared to the reference image 102 as shown in step 204. If the user notices a tint or hue on the predetermined image, the user then selects a bias color, and intensity to match the tint or hue observed on the 25 predetermined image. The user then inputs the bias color as shown in step 208 and intensity as shown in step 210 into the image output apparatus which then, as shown in step 212, adjusts its print engine accordingly. Using the example of Figure 1, if the user notices a medium magenta tint in the predetermined image, the user would select color bar D 104d, intensity level 3. It is also possible that more than one adjustment may be needed, therefore

the process may be repeated as often as necessary.

Referring now to FIGs 3 and 4 there is shown a reference 300 and method 400 for light-dark calibration of a color printer. As shown in FIG 3, the reference 300 comprises a sunlit side 302 and a shadow side 304. A sun icon 306 can be used to indicate which side is the sunlit side 302. The sides may also be labeled such as Sunlit Side 308 and Shadow Side 310. As shown in FIG 3, the image comprises a circle with two lines 312 similar to a clock at the 4 o'clock position on the sunlit side 302, and another circle with two lines 314 on the shadow side 304. The reference 300 should be an image that is sensitive to light-dark errors. Important details, such as the circles 312 and 314, are in the sunlit side 302 and shadow side 304. The user by comparing a print out from an image apparatus with the reference 300 can determine if detail is missing, and from which side.

The reference in FIG 3 shows the ideal output. However, it is also contemplated that the reference 300 may also have several other images with details missing on either the sunlit side 302 or the shadow side 304 so that the user can select a drawing most resembling the output for faster adjustments.

The method 400 begins at step 402 by printing an image from the image output device. At step 404 the user compares the image with the reference 300. If the image is acceptable then the process is done as shown in step 406. Otherwise, processing continues to step 408 where the user determines if the image is lighter or darker than the reference 300. If the image is lighter then as shown at step 410 the image output device is adjusted lighter, if the image is darker than the reference 300 then the image output device is adjusted darker as shown in step 412. The process may be repeated as often as necessary.

Both the aforementioned color calibration method 200 and light-dark density calibration method 400 can be performed either at the control panel of the image output device or by using a printer driver on a remote computer communicatively coupled to the output device. When using a printer driver, the desired reference image may be displayed on a video monitor coupled to the remote computer. The commands to print an image would be sent and inputting of the adjustment parameters may be also be performed either at the control panel or via the printer driver. Once the appropriate bias or intensity adjustment is made, then the

image output apparatus uses the adjustment parameters to adjust the output of the device.

The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment was chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of the ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance to the breadth to which they are fairly, legally and equitably entitled.